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$$= \prod_{r=1}^n D_r - x_r^2 \left| \begin{array}{ccccc} 1 & 0 & 0 & \dots & -1 \\ 0 & 1 & 0 & \dots & -1 \\ 0 & 0 & 1 & \dots & -1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{x_1^2}{D_1 - x_1^2} & \frac{x_2^2}{D_2 - x_2^2} & \frac{x_3^2}{D_3 - x_3^2} & \cdots & \frac{D_n}{D_n - x_n^2} \end{array} \right|$$

$$= \prod_{r=1}^n (D_r - x_r^2) \left| \begin{array}{ccccc} 1 & 0 & 0 & \dots & 0 \\ 0 & 1 & 0 & \dots & -1 \\ 0 & 0 & 1 & \dots & -1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{x_1^2}{D_1 - x_1^2} & \frac{x_2^2}{D_2 - x_2^2} & \frac{x_3^2}{D_3 - x_3^2} & \cdots & \frac{D_n}{D_n - x_n^2} + \frac{x_1^2}{D_1 - x_1^2} \end{array} \right|$$

adding last column to the first. Since the first row contains  $n-1$  zeros, this reduces the determinant to one of the  $(n-1)$ st order. Adding last column to the first we reduce to one of the  $(n-2)$ nd order. Repeat this process  $(n-1)$  times in all.

$$\text{Then } \Delta = \prod_{r=1}^n (D_r - x_r^2) \left[ \frac{D_n}{D_n - x_n^2} + \frac{x_1^2}{D_1 - x_1^2} + \frac{x_2^2}{D_2 - x_2^2} + \cdots + \frac{x_{n-1}^2}{D_{n-1} - x_{n-1}^2} \right]$$

$$= \prod_{r=1}^n (D_r - x_r^2) \left[ \frac{x_1^2}{D_1 - x_1^2} + \frac{x_2^2}{D_2 - x_2^2} + \cdots + \frac{x_{n-1}^2}{D_{n-1} - x_{n-1}^2} + \frac{x_n^2}{D_n - x_n^2} + 1 \right]$$

$$= \prod_{r=1}^n (D_r - x_r^2) \left[ \sum_{r=1}^n \frac{x_r^2}{D_r - x_r^2} + 1 \right].$$

Also solved by G. B. M. Zerr, V. M. Spunar, and J. Scheffer.

304. Proposed by C. N. SCHMALL, New York City.

A policeman on a motor-cycle starts in pursuit of an automobile when the latter has a headway of  $\frac{1}{2}$  a mile. A pedestrian who is  $\frac{1}{2}$  mile ahead of the auto and who is walking at the rate of 5 miles an hour, notices that when the auto overtakes him the policeman is only 5-12 of a mile behind the auto, and  $2\frac{1}{2}$  miles from where the officer started; he overtakes the auto. How long did the chase last?

Solution by G. B. M. ZERR, A. M., Ph. D., and the PROPOSER.

Let  $x$ =policeman's rate,  $y$ =auto's rate, and  $z$ =time for auto to overtake pedestrian.

Then  $(5z + \frac{1}{2})/y = (5z + \frac{1}{2} + \frac{1}{12})/x \dots (1)$ ,

$2/y = (2\frac{1}{2})/x \dots (2)$ .

(1)/(2) gives  $300z + 15 = 240z + 16$ .  $\therefore z = \frac{1}{60}$  hours = 1 minute.

Since it takes the policeman 1 minute to gain  $\frac{1}{12}$  mile, it will take him 6 minutes to overtake the auto and end the race.

In the statement of this problem, the semi-colon should be omitted after the word "started." With this omission the problem was solved as above by J. W. Clawson, V. M. Spunar, J. H. Meyer. R. D. Carmichael, A. H. Holmes, B. Kramer; J. Scheffer, J. K. Ellwood, and P. S. Berg, interpreting the problem as printed, agree in the answer being 2 hours, 36 minutes.

## GEOMETRY.

336. Proposed by F. H. HODGE, The University of Chicago.

A man owning a rectangular field  $b=300$  feet by  $a=600$  feet, wishes to lay out driveways of equal width having the diagonals of the field as center lines and such that the area of the driveways shall be  $n/m=$ one-half, of the area of the field. Determine the width of the driveways.

Solution by J. SCHEFFER, A. M., Hagerstown, Md.; NELLIE WOOD, Senior Class, Drury College, Springfield, Mo.; and A. H. HOLMES, Brunswick, Me.

Put  $AE=x$ ; then  $AG=\frac{bx}{a}$ ;  $\triangle EFK=\triangle GHL=\frac{b}{a} \cdot \frac{(a-2x)^2}{4}$ .

$$\therefore \text{space occupied by driveways} = ab - \frac{b}{a} (a-2x)^2.$$

$$\therefore ab - \frac{b}{a} (a-2x)^2 = \frac{n}{m} ab; \text{ whence}$$

$$x = \frac{1}{2}a \left( 1 - \sqrt{1 - \frac{n}{m}} \right).$$

$$\therefore \text{breadth of driveway} = \frac{ab}{\sqrt{(a^2+b^2)}} \left( 1 - \sqrt{1 - \frac{n}{m}} \right).$$

For  $a=600$ ,  $b=300$ ,  $n:m=1:2$ , we find breadth  $= 60(2\sqrt{5}-\sqrt{10})=78.572$  feet.

Also solved by B. Kramer, V. M. Spunar, G. I. Hopkins, J. H. Meyer, G. B. M. Zerr, and A. H. Bell.

337. Proposed by T. N. HILDEBRANT, The University of Chicago.

Required the locus of the vertices of the parabolae having a given focus and passing through a given point.

**Solution by the PROPOSER.**

Let  $O$  be the given focus and  $P$  the given point. From the properties of the parabola we see that the directrices of the parabolae passing through  $P$  will be the tangents to the circle of radius  $OP$  and center  $P$ . Hence the vertices will be the mid-points  $D$  of the perpendiculars from  $O$  to the tangents. From elementary geometry we have the triangles  $OCB$  and  $OAB$  equal, and therefore  $OC=OA=x_1$ , the abscissa of  $B$  the point of tangency, if we suppose  $O$  the origin of our system of coordinates. Hence  $OD=\frac{1}{2}x_1$ . Denote by  $\alpha$  the angle  $POC$ . Then we also have  $EPB=\alpha$ . Evidently

